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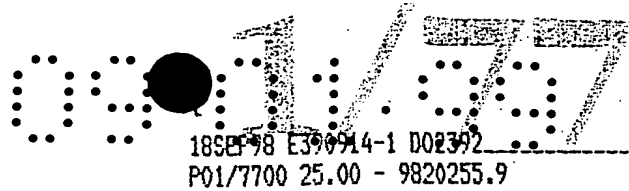
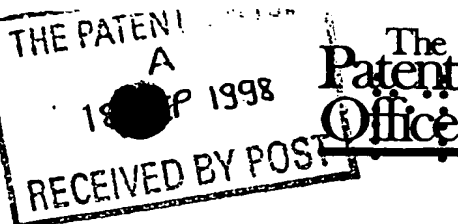
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1. Your reference	PB751/iv/GB/RGMS		
2. Patent application number (The Patent Office will fill in this part)	9820255.9		18 SEP 1998
3. Full name, address and postcode of the or of each applicant (underline all surnames)	ALBRIGHT & WILSON UK LIMITED 210-222 HAGLEY ROAD WEST OLDBURY WEST MIDLANDS B68 0NN		
Patents ADP number (if you know it)	6804264001		
If the applicant is a corporate body, give the country/state of its incorporation	ENGLAND		
4. Title of the invention	BIOCIDAL COMPOSITIONS AND TREATMENTS		
5. Name of your agent (if you have one)	R G M SAVIDGE		
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	ALBRIGHT & WILSON UK LIMITED PATENTS DEPARTMENT 210-222 HAGLEY ROAD WEST OLDBURY WEST MIDLANDS B68 0NN		
Patents ADP number (if you know it)	5249003		
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)	Date of filing (day / month / year)
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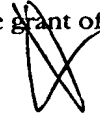
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Claim(s)	NONE
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Signature		Date	17/09/98
R G M SAVIDGE - By Power of Attorney			

12. Name and daytime telephone number of person to contact in the United Kingdom

MR R G M SAVIDGE
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BIOCIDAL COMPOSITIONS AND TREATMENTS

The present invention relates to synergistic biocidal mixtures of hydroxymethyl phosphonium biocides with certain non-foaming biopenetrants.

GB 2 145 708 describes biocidal uses of tetrakis (hydroxymethyl) phosphonium salts, referred to herein collectively as "THP". US 4 778 813 describes the biocidal use of quaternary ammonium polymers. GB 2 178 960 describes synergism between THP and surfactant. GB 2 228 680 describes synergism between THP and certain aldehydes.

THP formulations are increasingly widely used as biocides for water treatment in treating cooling water, process water e.g. in pulp and paper manufacture, drilling fluids and other aerobic water systems, as well as in anaerobic systems such as oil field formation water, injection water, produced water and water used in hydrostatic testing. Advantages include rapid and effective bactericidal activity and environmental acceptability. Particularly in systems where slime forming bacteria proliferate (e.g. in aerobic systems such as cooling water) it has been found desirable to use THP formulations containing synergistic amounts of a surfactant according to GB 2 178 960, in order to improve cost effective biocidal action. However such formulations cause foaming problems. Attempts to combine THP with other biocides (e.g. aldehydes), which do not cause foaming, have not been able to provide such effective biocidal action against slime forming bacteria, and/or have detracted from the favourable environmental profile of THP.

We have now discovered that combinations of THP with quaternary ammonium polymers and copolymers and/or water soluble glycol ethers, and/or aryl sulphonate formaldehyde copolymers provide strongly synergistic biocidal formulations which give excellent penetration of bacterial slime and improved activity against planktonic bacteria without causing excessive foam.

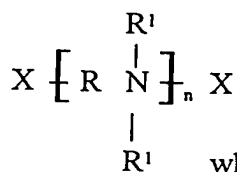
Our invention provides a biocidally synergistic mixture comprising THP and at least one biopenetrant synergist selected from quaternary ammonium polymers and copolymers, water soluble glycol ethers and sulphonated aryl formaldehyde copolymers.

According to a second embodiment the invention provides a method of treating aqueous systems contaminated, or liable to contamination, with bacteria, fungi or algae which comprises applying thereto separately or together a biocidally active amount of the components of a synergistic mixture as aforesaid.

The aqueous system may, for instance, be contaminated with bacterial slime. The invention is of use for treating aerobic systems and also for anaerobic systems.

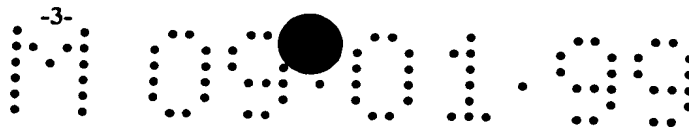
The THP salt is preferably the sulphate, chloride or phosphate. However any water soluble salt may be used including the nitrate, phosphite, bromide, fluoride, carbonate, acetate, formate, citrate, borate, or silicate. In fact any counter ion which is chemically compatible with the THP cation may be used, the main criteria for selection being economic.

The quaternary ammonium polymer may be any of those described in US 4 778 813. Particularly preferred is poly[oxyethylene(dimethyliminio)ethylene(dimethyliminio)ethylene dichloride]. This is a copolymer of NNN'N'-tetramethyl-1,2-diamino ethane with bis (2-chloroethyl) ether, which is referred to herein as "WSCP". The latter is the commercial name of the product used in example 1, which is sold by Buckman Laboratories. However any other water soluble polymer containing a plurality of quaternary ammonium groups may be used. Such compounds typically have the formula:



wherein each R is a divalent organic group constituting with the ammonium group a monomeric residue or separately selected from two or more comonomeric residues each R¹ is an alkyl or hydroxy alkyl group, preferably methyl or ethyl, X is hydrogen or a monovalent inorganic or organic end capping group and n is from 3 to 3000, e.g. 5 to 2000, especially 8 to 1000, e.g. 10 to 500, most preferably 20 to 100.

Some typical examples include:



Poly[hydroxyethylene(dimethyliminio)ethylene(dimethyliminio)methylene dichloride]
Poly[hydroxyethylene(dimethyliminio)-2-hydroxypropylene(dimethyliminio)-methylene dichloride]
N-[3-(dimethylammonio)propyl]-*N*[3-(ethyleneoxyethylenedimethylammonio)propyl]urea dichloride
-4-[1-tris(2-hydroxyethyl)ammonium chloride-2-butenyl]poly[1-dimethylammonium chloride-2-butenyl]tris(2-hydroxyethyl)ammonium chloride

The glycol ether is preferably a water soluble compound of the formula $\text{HO}[\text{CR}_2\text{CR}_2\text{O}]_n\text{R}'$ where each R is methyl, ethyl or preferably H, provided that the total number of carbon atoms per $[\text{CR}_2\text{CR}_2\text{O}]$ group does not exceed 4, more preferably is not more than 3 and most preferably is 2, R' is a lower hydrocarbon group such that the compound is water soluble, e.g. propyl, ethyl or preferably methyl and n is from 1 to 10, especially 1 to 5, typically 1 to 3, preferably 2.

The sulphonated aryl formaldehyde copolymer is preferably sodium naphthalene sulphonate formaldehyde condensate.

The biopenetrant synergist is not usually present in a greater weight concentration than the THP, although higher concentrations by weight based on THP, e.g. up to 10:1 or even 100:1 are technically possible but commercially undesirable. The proportion is preferably less 50% by weight based on the weight of THP, more usually less than 20%, typically less than 10%, especially less than 5%. Although very small amounts may be effective we prefer to use proportions of biopenetrant greater than 0.1% based on the weight of THP, usually greater than 0.5%, especially greater than 1%.

The biocide is typically supplied as a 10 to 75%, e.g. 20 to 60%, especially 30 to 50% by weight aqueous solution of THP containing from 0.1 to 10%, e.g. 0.2 to 5%, especially 0.5 to 2% of the synergist, based on the total weight of the solution.

Alternatively the composition may be supplied as a solid especially a powdery or granular solid coated in an acidic encapsulant such as adipic acid.

-4-

The mixture is typically used at a dosage of 1 to 1500ppm by weight THP based on the weight of water to be treated, usually 2 to 500, especially 5 to 250, e.g. 10 to 150.

According to a particular embodiment it has been found that mixtures of the aforesaid biopenetrant synergists with surfactants and THP salts provide an enhanced synergism. Such mixtures can provide even more effective biocidal activity, at substantially lower levels of both biocide and surfactant than are required for conventional mixtures of THP salts and surfactant.

Our invention accordingly further provides a biocidally synergistic mixture comprising: (A) THP; (B) at least one biopenetrant synergist selected from quaternary ammonium polymers and copolymers, water soluble glycol ethers and sulfonated aryl formaldehyde copolymers; (C) a surfactant.

The invention further provides a method of treating water with a biocidally active amount of said synergistic mixture.

Surfactants for use in our invention typically contain hydrophobic groups such as alkenyl, cycloalkenyl, alkyl, cycloalkyl, aryl, alkyl/aryl or more complex aryl (as in petroleum sulphonates) moieties having from 8 to 22, preferably 10 to 20, typically 12 to 18 carbon atoms and a hydrophilic moiety. Other hydrophobic groups included in the invention are polysiloxane groups.

The surfactant may for example consist substantially of an at least sparingly water-soluble salt of sulphonic or mono esterified sulphuric acids, e.g. an alkylbenzene sulphonate, alkyl sulphate, alkyl ether sulphate, olefin sulphonate, alkane sulphonate, alkylphenol sulphate, alkylphenol ether sulphate, alkylethanolamide sulphate, alkylethanolamidether sulphate, or alpha sulpho fatty acid or its ester each having at least one alkyl or alkenyl group with from 8 to 22, more usually 10 to 20, aliphatic carbons atoms.

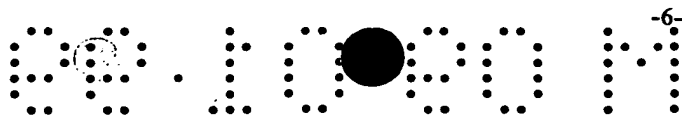
The expression "ether" hereinbefore refers to compounds containing one or more glyceryl groups and/or an oxyalkylene or polyoxyalkylene group especially a group containing from 1 to 20 oxyethylene and/or oxypropylene groups. One or more oxybutylene groups may additionally or alternatively be present. For example, the sulphonated or sulphated surfactant

may be sodium dodecyl benzene sulphonate, potassium hexadecyl benzene sulphonate, sodium dodecyl dimethyl benzene sulphonate, sodium lauryl sulphate, sodium tallow sulphate, potassium oleyl sulphate, ammonium lauryl monoethoxy sulphate, or monoethanolamine cetyl 10 mole ethoxylate sulphate.

Other anionic surfactants useful according to the present invention include alkyl sulphosuccinates, such as sodium di-2-ethylhexylsulphosuccinate and sodium dihexylsulphosuccinate, alkyl ether sulphosuccinates, alkyl sulphosuccinamates, alkyl ether sulphosuccinates, acyl sarcosinates, acyl taurides, isethionates, soaps such as stearates, palmitates, resinates, oleates, linoleates, and alkyl ether carboxylates. Anionic phosphate esters and alkyl phosphonates, alkyl amino and imino methylene phosphonates may also be used. In each case the anionic surfactant typically contains at least one aliphatic hydrocarbon chain having from 8 to 22, preferably 10 to 20 carbon atoms, and, in the case of ethers, one or more glyceryl and/or from 1 to 20 oxyethylene and/or oxypropylene and/or oxybutylene groups.

Preferred anionic surfactants are sodium salts. Other salts of commercial interest include those of potassium, lithium, calcium, magnesium, ammonium, monoethanolamine, diethanolamine, triethanolamine, alkyl amines containing up to seven aliphatic carbon atoms, and alkyl and/or hydroxyalkyl phosphonium.

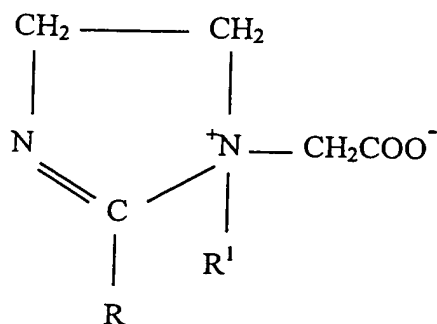
The surfactant may optionally contain or consist of nonionic surfactants. The nonionic surfactant may be, e.g. a C₁₀₋₂₂ alkanolamide of a mono or di- lower alkanolamine, such a coconut monoethanolamide. Other nonionic surfactants which may optionally be present, include tertiary acetylenic glycols, polyethoxylated alcohols, polyethoxylated mercaptans, polyethoxylated carboxylic acids, polyethoxylated amines, polyethoxylated alkylolamides, polyethoxylated alkylphenols, polyethoxylated glyceryl esters, polyethoxylated sorbitan esters, polyethoxylated phosphate esters, and the propoxylated or ethoxylated and propoxylated analogues of all the aforesaid ethoxylated nonionics, all having a C₈₋₂₂ alkyl or alkenyl group and up to 20 ethyleneoxy and/or propyleneoxy groups. Also included are polyoxypropylene/polyethylene oxide copolymers, polyoxybutylene/polyoxyethylene copolymers and polyoxybutylene/polyoxypropylene copolymers. The polyethoxy, polyoxypropylene and polyoxybutylene compounds may be endcapped with, e.g. benzyl groups to reduce the foaming tendency.



Compositions of our invention may contain amphoteric surfactant.

The amphoteric surfactant may for example be a betaine, e.g. a betaine of the formula:-

$R_3N^+CH_2COO^-$, wherein each R is an alkyl, cycloalkyl, alkenyl or alkaryl group and preferably at least one, and most preferably not more than one R, has an average of from 8 to 20, e.g. 10 to 18 aliphatic carbon atoms and each other R has an average of from 1 to 4 carbon atoms. Particularly preferred are the quaternary imidazoline betaines of the formula:-



wherein R and R' are alkyl, alkenyl, cycloalkyl, alkaryl or alkanol groups having an average of from 1 to 20 aliphatic carbon atoms and R preferably has an average of from 8 to 20, e.g. 10 to 18 aliphatic carbon atoms and R' preferably has 1 to 4 carbon atoms. Other amphoteric surfactants for use according to our invention include alkyl amine ether sulphates, sulphobetaines and other quaternary amine or quaternised imidazoline sulphonic acids and their salts, and Zwitterionic surfactants, e.g. N-alkyl taurines, carboxylated amido amines such as $RCONH(CH_2)_2N^+(CH_2CH_2CH_3)_2CH_2COO^-$, and amino acids having, in each case, hydrocarbon groups capable of conferring surfactant properties (e.g. alkyl, cycloalkyl alkenyl or alkaryl groups having from 8 to 20 aliphatic carbon atoms). Typical examples include 2-tallow alkyl, 1-tallow amido alkyl, 1-carboxymethyl imidazoline and 2-coconut alkyl N-carboxymethyl 2 (hydroxyalkyl) imidazoline. Generally speaking any water soluble amphoteric or Zwitterionic surfactant compound which comprises a hydrophobic portion including C_{8-20} alkyl or alkenyl group and a hydrophilic portion containing an amine or quaternary ammonium group and a carboxylate, sulphate or sulphonic acid group may be used in our invention.

Compositions of our invention may also include cationic surfactants.

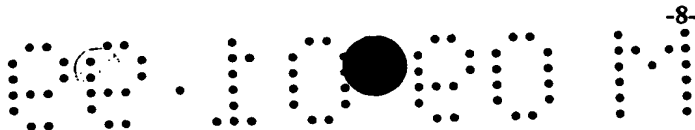
The cationic surfactant may for example be an alkylammonium salt having a total of at least 8, usually 10 to 30, e.g. 12 to 24 aliphatic carbon atoms, especially a tri or tetra-alkylammonium salt. Typically alkylammonium surfactants for use according to our invention have one or at most two relatively long aliphatic chains per molecule (e.g. chains having an average of 8 to 20 carbon atoms each, usually 12 to 18 carbon atoms) and two or three relatively short chain alkyl groups having 1 to 4 carbon atoms each, e.g. methyl or ethyl groups, preferably methyl groups. Typical examples include dodecyl trimethyl ammonium salts. Benzalkonium salts having one 8 to 20 C alkyl group two 1 to 4 carbon alkyl groups and a benzyl group are also useful.

Another class of cationic surfactant useful according to our invention comprises N-alkyl pyridinium salts wherein the alkyl group has an average of from 8 to 22, preferably 10 to 20 carbon atoms. Other similarly alkylated heterocyclic salts, such as N-alkyl isoquinolinium salts, may also be used.

Alkylaryl dialkylammonium salts, having an average of from 10 to 30 aliphatic carbon atoms are useful, e.g. those in which the alkylaryl group is an alkyl benzene group having an average of from 8 to 22, preferably 10 to 20 carbon atoms and the other two alkyl groups usually have from 1 to 4 carbon atoms, e.g. methyl groups.

Other classes of cationic surfactant which are of use in our invention include alkyl imidazoline or quaternised imidazoline salts having at least one alkyl group in the molecule with an average of from 8 to 22 preferably 10 to 20 carbon atoms. Typical examples include alkyl methyl hydroxyethyl imidazolinium salts, alkyl benzyl hydroxyethyl imidazolinium salts, and 2 alkyl-1-alkylamidoethyl imidazoline salts.

Another class of cationic surfactant for use according to our invention comprises the amido amines such as those formed by reacting a fatty acid having 2 to 22 carbon atoms or an ester, glyceride or similar amide forming derivative thereof, with a di or poly amine, such as, for example, ethylene diamine or diethylene triamine, in such a proportion as to leave at least one free amine group. Quaternised amido amines may similarly be employed.



Alkyl phosphonium and hydroxyalkyl phosphonium salts having one C₈₋₂₀ alkyl group and three C₁₋₄ alkyl or hydroxyalkyl groups may also be used as cationic surfactants in our invention.

Typically the cationic surfactant may be any water soluble compound having a positively ionised group, usually comprising a nitrogen atom, and either one or two alkyl groups each having an average of from 8 to 22 carbon atoms.

The anionic portion of the cationic surfactant may be any anion which confers water solubility, such as formate, acetate, lactate, tartrate, citrate, chloride, nitrate, sulphate or an alkylsulphate ion having up to 4 carbon atoms such as methosulphate. It is preferably not a surface active anion such as a higher alkyl sulphate or organic sulphonate.

Polyfluorinated anionic, nonionic or cationic surfactant may also be useful in the compositions of our invention. Examples of such surfactants are polyfluorinated alkyl sulphates and polyfluorinated quaternary ammonium compounds.

Compositions our invention may contain a semi-polar surfactant such as an amine oxide, e.g. an amine oxide containing one or two (preferably one) C₈₋₂₂ alkyl group, the remaining substituent or substituents being preferably lower alkyl groups, e.g. C₁₋₄ alkyl groups or benzyl groups.

Particularly preferred for use according to our invention are surfactants which are effective as wetting agents, typically such surfactants are effective at lowering the surface tension between water and a hydrophobic solid surface. We prefer surfactants which do not stabilise foams to a substantial extent.

Mixtures of two or more of the foregoing surfactants may be used. In particular mixtures of non-ionic surfactants with cationic and/or amphoteric and/or semi polar surfactants or with anionic surfactants may be used. Typically we avoid mixtures of anionic and cationic surfactants, which are often less mutually compatible.

Preferably the THP compound and the surfactant are present in a relative weight concentration of from 1:1000 to 1000:1, more usually 1:50 to 200:1, typically 1:20 to 100:1, most preferably 1:10 to 50:1, e.g. 1:1 to 20:1 especially 2:1 to 15:1.

Effective doses of the mixture are typically from 0.5 ppm to 2,000 ppm, more usually 2 ppm to 1,000 ppm, e.g. 5 ppm to 500 ppm especially 10 to 250 ppm.

The composition may additionally contain other biocides, water dispersants, antifoams, solvents, scale inhibitors, corrosion inhibitors, oxygen scavengers and/or flocculants.

Our invention includes aqueous solutions containing a biocidally active concentration of a composition of the invention. Such solutions may be water systems or aqueous based products containing functional ingredients as described in GB 2 145 708. Our invention also includes anhydrous, and concentrated aqueous, formulations adapted to provide the aforesaid products on dilution with water.

Scale or corrosion inhibitors which may be added to the water to be treated in conjunction with the present invention include phosphonates, polymaleates, polyacrylates, polymethacrylates, polyphosphates, phosphate esters, soluble zinc salts, nitrite, sulphite, benzoate, tannin, ligninsulphonates, benzotriazoles and mercaptobenzothiazoles all added in conventional amounts. The scale and/or corrosion inhibitors may be added to the water separately from or in association with the phosphonium compound and surfactant. There may be added to the water to be treated oxygen scavengers, flocculants such as polyacrylamide dispersants, antifoams such as silicones or polyethyleneoxylated antifoams or other biocides such as tin compounds or isothiazolones.

The mixture according to our invention may be prepared in situ by adding the THP, the biopenetrant synergist, and optionally the surfactant separately to the water system to be treated. Alternatively and preferably the components may be premixed, either alone, provided that they are miscible in the desired proportions, or with water or other solvents including C₁₋₄ monohydric and polyhydric alcohols, ketones, dispersants such as polyelectrolytes or solubilizers such as hydrotopes, e.g. sodium toluene sulphonate or sodium xylene sulphonate, sufficient to ensure a stable homogenous mixture. Typically trishydroxymethyl phosphonium salts are miscible with cationic surfactants of the quaternary

ammonium and phosphonium type, but mixtures with non-ionic surfactants may require dilution with water or solvents.

The microorganisms to be treated are usually bacteria, fungi, yeasts, and algae that grow in aquatic environments,. Included in this classification are sulphate reducing bacteria, e.g. Desulphovibrio, which may occur in oil installations, iron bacteria, e.g. Gallionella and slime forming bacteria, e.g. Pseudomonas, which last are particularly troublesome in aerated aqueous systems.

The water to be treated may be industrial cooling water, e.g. for power stations or chemical plants or for steel or paper or brewing and may be used in closed circuit or in open circuit involving evaporation in cooling towers. Alternatively the water may be process water, especially process water containing significant sources of nutrients for microorganisms such as process water for paper making plants and breweries. Injection water or drilling fluids for oil fields or water produced from oil fields or water used in reverse osmosis plants, e.g. to provide industrial processes or boiler feed water, may be treated.

Other aquatic environments which may be treated with the hydroxy-alkyl phosphorus compounds and surfactants according to the method for the invention are cooling or process water in board mills, fertiliser manufacture, oil refineries, primary metals manufacture, e.g. steel or copper, petrochemicals, rubber manufacture, textile and fabric industries, industrial gas manufacture, minerals recover, glass and ceramic manufacture, food industry, leather manufacture, heavy and light engineering, including metal fabrication and automotive engineering, furniture manufacture, electronics industry and surface coating and adhesives manufacture and other manufacturing industries.

The process is also applicable to the treatment of geothermal water, water in domestic, industrial and institutional central heating and air conditioning systems and water used for hydrostatic testing of pipelines and vessels, swimming baths and as cooling water for ships and marine engines.

The invention is also applicable to the control of microbial contamination in a wide variety of aqueous based products. For example compositions of the invention may be added to a variety of solutions and emulsion compositions such as paints, cutting oils, bitumen and tar emulsions, adhesives, weedkillers and insecticides, as well as to solid or concentrated compositions for addition to water in the preparation of such products. The invention, therefore, further provides aqueous based products which are subject to microbial spoilage to which has been added a bacteriostatic or bactericidal quantity of a THP salt, a biopenetrant synergist as aforesaid and, optionally, a surfactant. Typically such compositions consist of aqueous solutions, suspensions or emulsions of at least one functional ingredient, together with a minor proportion of a composition of the invention, sufficient to inhibit growth of microorganisms therein.

The systems to which the invention is particularly applicable are those involving the circulation or storage of substantial quantities of water, under conditions favouring the multiplication of bacteria, especially hardy bacteria such as *P. Aeruginosa*, e.g. conditions involving maintaining or periodically raising the water to super ambient temperatures favouring bacterial proliferation, or maintaining nutrients for the bacteria in the water systems.

The invention will be illustrated by the following examples:-

Example 1

THPS/WSCP mixture was compared with two commercial THP/anionic surfactant products for control of legionella pneumophila.

METHODOLOGY

Parameter	Details
Test medium	Sterile WHO Standard hardness water (total hardness 342mg litre ⁻¹) plus 3mg litre ⁻¹ iron as ferric sulphate
Biocides	Stock solutions 10 x the concentration to be tested Are prepared in WHO standard hardness water
pH	8.0 ± 0.2
pH adjuster	Boric acid/borax buffer as contained in the test Medium
Test organism	<i>L pneumophila</i> sg 1 (NCTC 11192)
Test volume	10ml
Contact temp	21 ± 1°C
Contact times	0, 3, 4 and 6 hours
Inoculum level	To give an initial concentration of approximately 1 x 10 ⁵ cfu/litre
Preparation of inoculum	Resuscitate test organism from lyophilised culture. Prepare 48h plate culture on BCYE agar. Hold at 4°C overnight. Suspend in 10ml of test medium.
Test method	Add 1ml of biocide stock solution to 8ml of test Medium. Control contains 9ml of test medium only. At time 0h add 1ml of inoculum. After the Appropriate contact times remove 1ml and make serial 10 x dilutions.
Enumeration method	By performing Miles and Misra dilution counts onto BCYE agar plates.
Replication	Spot 33 microlitres of each dilution in triplicate onto dry BCYE agar plates to obtain a mean count of surviving legionellae.
Plate incubation temperature	37 ± 1°C
Plate incubation period	7 days
Expression of results	Give number of control and surviving legionellae and the log 10 reduction in numbers of biocide-treated cell suspensions compare to the appropriate controls.

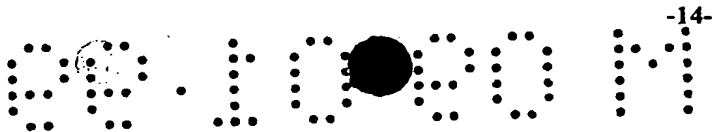
RESULTS

The results are summarised below

Product	3 Hour Contact time			4 Hour Contact Time			6 Hour Contact Time		
	25ppm	50ppm	100ppm	25ppm	50ppm	100ppm	25ppm	50ppm	100ppm
34% THP 2% anionic surfactant (Comparison A)	1 x 10 ³	6 X 10 ²	1.6 x 10 ³	1.5 x 10 ²	15	ND	30	ND	ND
74% THP 1% anionic surfactant (Comparison B)	6 x 10 ⁴	4.5 x 10 ²	ND	1.4 x 10 ⁴	6 x 10 ²	ND	4.5 x 10 ²	ND	ND
50% active THP / 0.7% WSCP (Example)	3 x 10 ³	ND	ND	5.3 x 10 ²	ND	ND	30.00	ND	ND

- Notes: i) ND - Non Detected
 ii) The control was 1 x 10⁵
 iii) The following conclusions apply:-
- A - Good activity within 4 hours at 50ppm or above
 - B - Good activity within 3 hours at 100 ppm or 6 hours at 50ppm
 - Example - Good activity within 3 hours at 50 ppm or above

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The example of the invention also showed superior performance to conventional THP surfactant formulations, to WSCP alone and to THP alone in reducing planktonic bacteria.

The example gave less than half the foaming observed using surfactant containing formulations.

Example 2

An aqueous solution comprising 50% THPS and 2% WSCP was added to alginate beads infected with sulphate reducing bacteria. When dosed at 250ppm, solution gave a 100 fold reduction in bacterial counts, compared with a control, after two weeks incubation.

At 500ppm the solution gave a total kill.

EXAMPLE 3

An aqueous solution comprising 50% THPS and 2% methyl carbitol (diethylene glycol monomethyl ether) was added to alginate beads infected with sulphate reducing bacteria. When dosed at 250ppm, the solution gave a 100 fold reduction in bacterial counts, compared with a control, after two weeks incubation. A mixture of 50% THP and 2% cationic surfactant was inactive at this concentration. At 500ppm the solution gave a total kill.

The example of the invention also showed superior performance to conventional THP surfactant formulations, to methyl carbitol and to THP alone in controlling both sulphate reducing and planktonic aerobic bacteria.

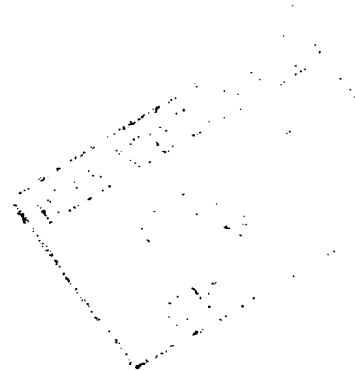
The example gave less than half the foaming observed using surfactant containing formulations.

The mixture also gives effective control over fungi and algae.

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EXAMPLE 4

The alginate bead test of examples 2 and 3 was repeated using sodium naphthalene sulphonate/formaldehyde condensate as the synergist. As 250ppm the solution gave a 100 fold reduction in bacterial counts after two weeks incubation. At 500ppm the solution gave a total kill. The volume of foam generated when air was bubbled through the system containing 750ppm of the active biocidal mixture was half that using THP alone.



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